ERT
ENVIRONMENTAL RESEARCH & TECHNOLOGY, INC.
PORTER BUILDING, 10th FLOOR, 601 GRANT STREET, PITTSBURGH, PENNSYLVANIA 15219

ERT Document No. P-A833-100
September 29, 1981

Mr. Edward J. Schwartzbauer, Esq.
Dorsey, Windhorst, Hannaford,
Whitney & Halladay
2200 First Bank Place East
Minneapolis, Minnesota 55402

Dear Ed:

We have summarized for you our opinions on those technical issues we believe central to the determination of whether remedial actions are necessary at St. Louis Park as well as our thoughts on the experimental plans that are vital to the collection of engineering information for use in the possible alteration of the existing St. Louis Park water treatment system should that be needed. The central water quality issue of concern to us is the significance of trace levels of polynuclear aromatic hydrocarbons (PAH) in the untreated (raw) waters from certain St. Louis Park wells.

Summary

The basic items that must be addressed in order to determine the need for any additional PAH removal treatment system for any St. Louis Park well are (1) an appropriate goal for the level of PAH desired in the treated water; (2) the quality of the raw well waters for all relevant constituents, not just PAH; and (3) the effect of existing treatment operations on PAH. If, and only if, additional treatment is shown to be necessary, then these two other items must be addressed: (A) the viable and cost-effective treatment options that warrant further study; and (B) the fundamental performance parameters required to design and operate a full-scale treatment system.

The studies conducted to date on evaluating the nature, extent, and possible treatment of trace levels of PAH in certain St. Louis Park well waters have not adequately addressed these basic items. The status and shortcomings of efforts to date in each of these areas, based on our present knowledge, together with recommendations for correcting these shortcomings, are summarized below. The balance of this letter is then devoted to a more detailed discussion of each item.

A criterion for the acceptable concentration of PAH in finished drinking water has not been explicitly stated for St. Louis Park. Such a criterion is required to judge the need for and effectiveness of any PAH removal treatment system and should be based on the practical considerations relevant to the St. Louis Park situation as well as the general health concerns that such a criterion must address.

Neither the quality of raw St. Louis Park well waters nor the ability of existing treatment systems to remove PAH have been accurately determined. Careful analytical study and a review of the substantial evidence suggesting that the existing systems may significantly remove PAH are needed.

The pilot PAH treatment studies performed to date at St. Louis Park have not provided the engineering design data required to cost, design, and operate a full-scale treatment system.

Finished Water PAH Quality Criteria

We use the word "criterion" to mean a constituent concentration in finished water supplied to the public that is associated with a degree of predicted health effect and upon which engineering or scientific judgments may be based. Various criteria for PAH, which to our knowledge have not been made explicit, have been used to date in St. Louis Park to close wells, seek alternate water supplies, and call for additional water treatment. To judge the basis for these kinds of decisions and to judge the effectiveness of an operating treatment system, it is necessary to have an explicitly stated water quality criterion for PAH. We feel that there are three basic facts which need to be recognized in establishing a practical criterion for the specific case of St. Louis Park.

First, a complex mixture of trace amounts of many individual PAH compounds is present in raw waters of some St. Louis Park wells. The raw water quality data collected by the Minnesota Department of Health (MDH) and other contractors show that suspect carcinogenic PAH are generally present at much lower concentrations than non-carcinogenic PAH. We believe that a workable criterion should focus on the characterization and control of suspected carcinogenic PAH.

Second, PAH occur ubiquitously in nature in soil, air, water and foodstuffs from both natural and anthropogenic sources.[1]* Trace (part per trillion) levels of PAH have been observed in pristine ground waters[2] and in all U.S. drinking water supplies - raw and treated - that have been analyzed with sufficiently sensitive techniques.[3] We are aware of no substantial evidence to date that these levels pose a significant public health risk.

Third, any criterion must recognize technical constraints in measuring and controlling PAH levels in drinking water. Complete removal (i.e. to absolute zero) of PAH by treatment is unobtainable, and there are limits

*Footnotes are included at the end of this letter.

on the levels that can be achieved with any given treatment technique.[4] There are also limits to practical analytical detection levels, which are clearly important in monitoring for compliance with any criterion. Without careful definition of a particular analytic protocol, for example, it makes no sense to simply state that PAH should be kept below detectable levels. Indeed, the definition of an analytic protocol is essential to the resolution of any technical issues.

We believe there are two basic approaches available for establishing numerical criterion for PAH in drinking water. One approach is to base the criterion on measured toxicological properties of PAH. The other approach is to base the criterion on multimedia environmental background levels for PAH, on the basis that PAH water quality corresponding to such levels does not result in excess risk since all individuals are exposed to similar amounts, independent of whether these amounts do produce some adverse health effect. In either case, a criterion needs to be explicit in stating the specific PAH compound(s) included, which, as we said above, should focus on suspected carcinogenic compounds.

Raw Water Quality

It is necessary to characterize reliably both the amounts and variability of PAH and other relevant constituents in St. Louis Park well waters before any potential public health problem can be determined. Normal water quality constituents (e.g. major and minor anions and cations, total organic carbon) need to be characterized because they may affect or be affected by the design and operation of a PAH treatment system. PAH concentrations need to be accurately characterized in order to determine the level of treatment required, if any.

Both of the PAH treatment studies conducted to date at St. Louis Park have shown considerable variations in PAH levels measured in raw water from well number 15 (the well studied in both cases)[5], as have the regular analyses of raw water from this and other St. Louis Park wells by the MDH. These variations result from some combination of sampling and analysis variances and true fluctuations in the quality of the raw water. It is important to determine the relative contributions and significance of these causes before the need for treatment can be evaluated.

An example of the importance of understanding sampling and analysis variances is provided by results reported from Serco's July 1979 activated carbon pilot study. Comparisons of nine split samples analyzed by both the MDH and Serco during this study typically show differences by as much as a factor of ten to one hundred or more in the results obtained for

specific PAH compounds. Analytical variations of this magnitude are clearly significant in deciding if a well water exceeds a quality criterion or in evaluating the effectiveness of a treatment method. What is required in making these judgments is a known level of confidence in both the absolute and relative accuracy of the data being used.

We believe that the work required to better resolve the causes and significance of raw water PAH variations is (1) agreement on protocols for well sampling, sample handling, extraction and analysis techniques and then (2) sampling of the wells in question using these protocols with analyses for relevant constituents as well as PAH.

Effect of Existing Treatment

The extent of PAH removal that can be obtained by the different existing treatment systems at the various St. Louis Park wells needs to be ascertained before any add-on treatment systems are investigated. This is required in order to determine if PAH levels are acceptable after conventional treatment of the raw water. This issue is important because, as we pointed out during our October 9, 1980 meeting with the U.S. Attorney, et al, there is evidence that the existing treatment systems in St. Louis Park, especially those with iron removal treatment, as at well number 15, can provide significant PAH removal by themselves. The evidence includes results from Serco's July 1979 work,[6] as well as results from the open literature on PAH occurrence in public drinking water supplies with conventional treatment systems.[7]

The degree of PAH removal by existing St. Louis Park treatment systems can be readily determined by reactiviting the closed wells (with discharge of the water to sewer, if desired) and analyzing PAH levels in samples collected before and after each treatment step. Major and minor constituents should also be analyzed. Both chlorination and iron removal (by oxidation and sand filtration) treatment should be separately characterized since they may have different effects and since some wells do not have iron removal, while all have chlorination.

We believe it is premature to study additional treatment options, given the lack of information concerning the effect of existing treatment. Therefore, such study should be undertaken if, but only if, existing treatment is shown to be inadequate. Nevertheless, a few comments seem in order with respect to the studies done to date, and what steps might be taken if needed.

Study of PAH Treatment Options

Thorough literature reviews and cost analyses of candidate treatment methods should be performed before any pilot treatment studies or designs are implemented. This information is requied to make preliminary capital and operating cost estimates for the various add-on treatment candidates in order to identify the most cost-effective method(s) for further pilot studies.

Such a survey and analysis of applicable treatment methods is important because, as we discussed during our October 9, 1980 meeting, there are add-on treatment options other than activated carbon which may be more cost-effective for use at St. Louis Park. In particular, we suggested that treatment with hydrogen peroxide under ultraviolet radiation could be an effective option. While E.A. Hickok and Associates performed some limited investigation of this technique as part of their studies, their work, as they stated, was not sufficient to define the applicability or design requirements of hydrogen peroxide treatment.[8]

Testing of PAH Treatment Options

Once a raw well water has been accurately characterized and shown to exceed an established criterion for PAH after treatment by any existing system, and after literature review and preliminary cost study have identified cost-effective treatment options, pilot studies are then appropriate for the treatment method(s) selected. The purpose of such pilot studies is to determine the fundamental performance parameters required to cost, design, build and operate a treatment system.

Five basic components must be part of any treatment study. Any study must (1) be performed with the actual well water in question, (2) determine the basic engineering design and performance parameters required to extrapolate accurately pilot results to the design and operation of a full-scale system, (3) examine the effect of other constituents on and by the treatment system, (4) determine the nature of any reaction by-products and (5) subject all data obtained to rigorous statistical analysis in order to quantify the significance and reliability of the results.

We believe that the activated carbon pilot treatment studies commissioned to date by St. Louis Park have inadequately addressed most of the above items. Probably the most important shortcoming is that the studies have not provided all of the performance parameters required confidently to design and operate a full-scale activated carbon system. For example, the powdered activated carbon (PAC) studies have not distinguished between PAH removal by PAC in suspension and by PAC

ERT

accumulated on the sand filter downstream. This is a crucial point in a PAC treatment design because it affects the dosage, residence times, and backwash cycle times required. Similarly, the granular activated carbon (GAC) studies have not determined carbon adsorption capacities, which is an important design parameter that controls the rate at which the carbon needs to be replaced or regenerated. Other items requiring study for either PAC or GAC treatment are methods, cost, and effectiveness for disposal and/or regeneration of spent carbon (and backwash water, if applicable) and the effects of different brands of carbon, which can significantly affect performance.9

We hope this letter is useful in outlining the important technical issues involved in PAH treatment studies at St. Louis Park. Please call if you have any questions or further requests.

Sincerely,

JCC/lr

John C. Craun, P.E.
Manager, Regulatory Engineering Group
Environmental Engineering Center

F.C. McMichael

Francis Clay McMichael
Senior Technical Advisor
Environmental Engineering Center

ERT

FOOTNOTES

1 See, for example, Blumer, Max, Scientific American, Vol. 234, No. 3, pp. 35ff, March 1976; Santodonato, et al, Multimedia Health Assessment Document for Polycyclic Organic Matter, prepared for U.S. EPA Health Effects Research Laboratory by Syracuse Research Corp., October 1979; Shabad, L.M., The Circulation of Carcinogens in the Environment, NTIS No. PB0297507, June 1979; and Andelman, J.B. and J.E. Snodgrass, "Incidence and Significance of Polynuclear Aromatic Hydrocarbons in the Water Environment", in Critical Reviews in Environment Control, Vol. 4, No. 1, CRC Press, Jan. 1974, pp 69-83.

2 Typical PAH levels in uncontaminated ground waters are on the order of 50 parts per trillion. See Santodonato, et al (op cit); Andelman and Snodgrass (op cit); and R.M. Harrison, et al, "Review Paper - Polynuclear Aromatic Hydrocarbons in Raw, Potable and Waste Waters", Water Research Vol. 9, pp 331-346, 1975.

3 See references above, plus P.K. Sorrell, et al, "A Review of Occurrences and Treatment of Polynuclear Aromatic Hydrocarbons", U.S. EPA Office of Drinking Water, EPA-600/D-81-066, February 1981 and Basu, D.K. and J. Saxena, Environmental Science & Technology Vol. 12, No. 7, July 1978, pp 795-798.

4 Eugene A. Hickok and Associates' study on activated carbon treatment for St. Louis Park, for example, concluded that removal of PAH with raw water concentrations below 20 parts per trillion is difficult ("Report on Drinking Water Treatment and Remedy Evaluation for St. Louis Park, Minnesota", April 1981). Sorrell, et al (op cit) similarly concluded that activated carbon appears to be uneconomical for removal of PAH at levels less than 30 parts per trillion (p. 24).

5 E.A. Hickok and Associates (op cit) and Serco Laboratories, "Summary Report on the City of St. Louis Park Activated Carbon Pilot Plant Study - July and October 1979", January 11, 1980.

6 Table 1 of the Serco report (op cit) shows over 80% removal of fluoranthene and over 30% removal of phenanthrene/pyrene due to sand filtration alone. The data which show these removals are felt to be sufficiently accurate to support this conclusion because they resulted from replicate analyses by a single laboratory (MDH). The problem of absolute accuracy as indicated by comparisons between laboratories, as discussed in the previous section, still remains, however.

7 See especially Sorrell, et al (op cit), also Basu & Saxena (op cit) and Harrison, et al (op cit).

FOOTNOTES (Continued)

8 Hickok's work was inconclusive because they tested hydrogen peroxide with a twenty second ultraviolet exposure period while the literature indicates that longer exposure times (hours) are required for effective treatment (L. Berglind, et al, 1979, Removal of Organic Matter From Water by UV and Hydrogen Peroxide. Proc. of Conf. on Oxidation Techniques in Drinking Water Treatment, Karlsruhe, FRG. EPA-570/9-79-020). In spite of this short residence time, Hickok's data do show reductions of about 25% and 40% for fluoranthene and pyrene, respectively, which is significant considering the short reaction time.

9 See, for example, P.N. Cheremisinoff and F. Ellerbusch, Carbon Adsorption Handbook, Chapter 1, Ann Arbor Science Publishers, 1978.